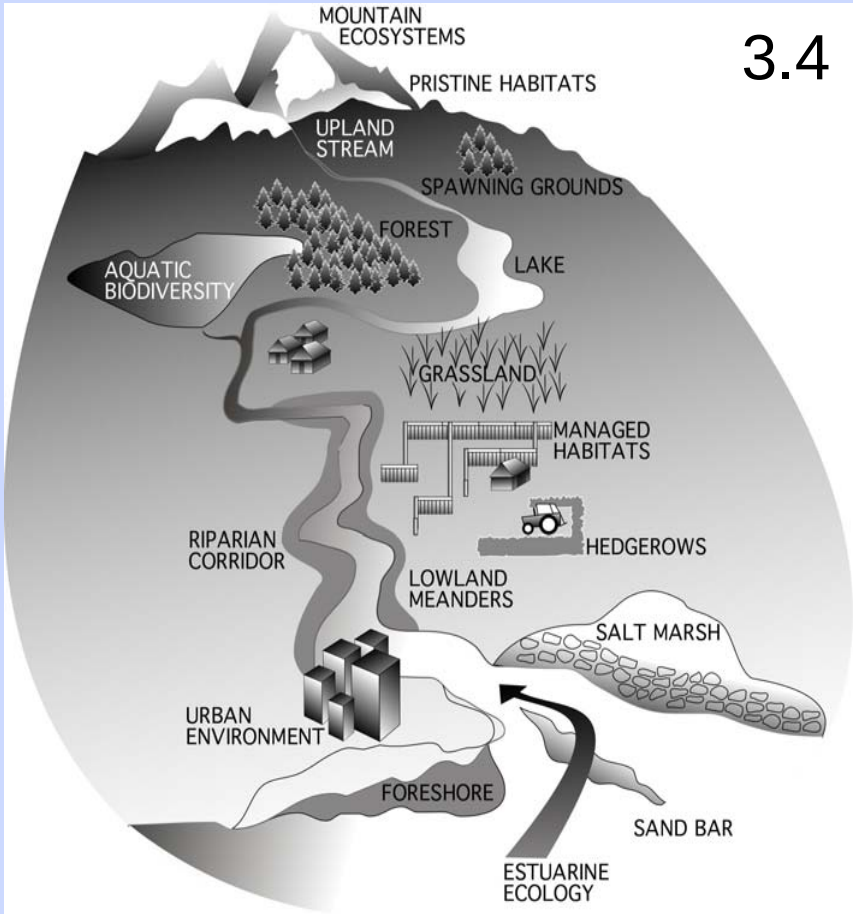
WP 3.5 MANAGEMENT TO ENHANCE WATER QUALITY

"should lead to effective policy and guidance on the management and enhancement of water resources and water quality, under present and future environmental conditions, focussed by an understanding of stakeholder needs and economic cost

"helping decisions happen"

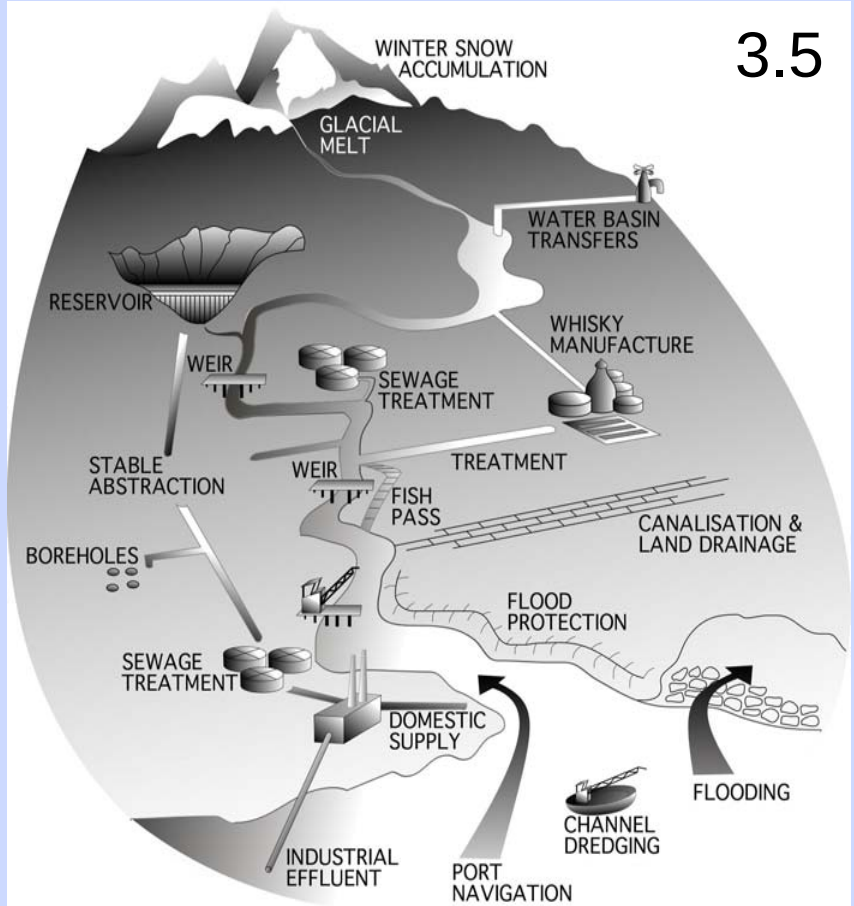
Shared Perspectives

3.4



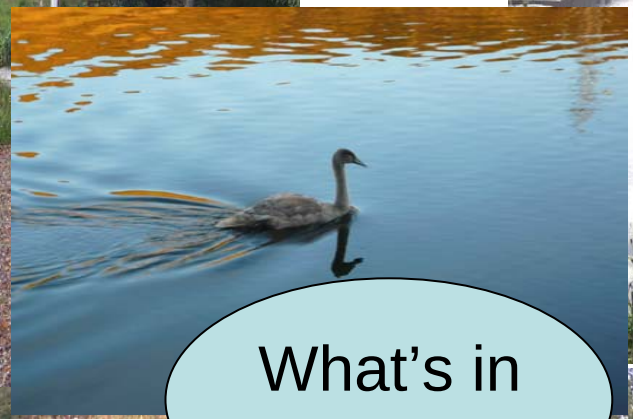
An ecological perspective

3.5

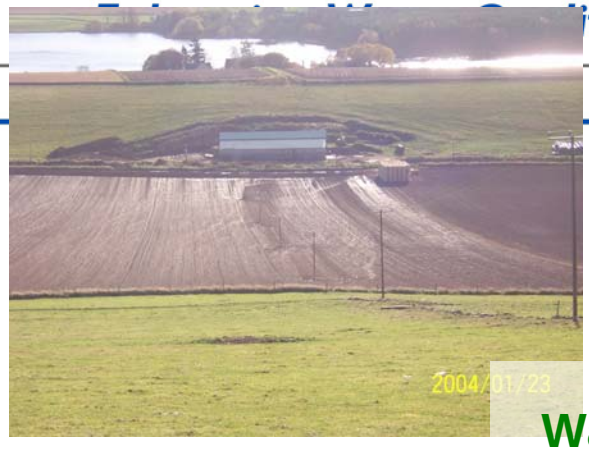


A resource management perspective

Reconciling multiple pressures



What's in it for me?



efficiency

Water costs and values

Effective solutions

integration

inclusion

Governance

Approach to integrating measures with costs and values

1. Set standards of Good Ecological Status (GES) based on best science evidence

2. Effectiveness and Cost:effectiveness analysis (CEA) to prioritise measures

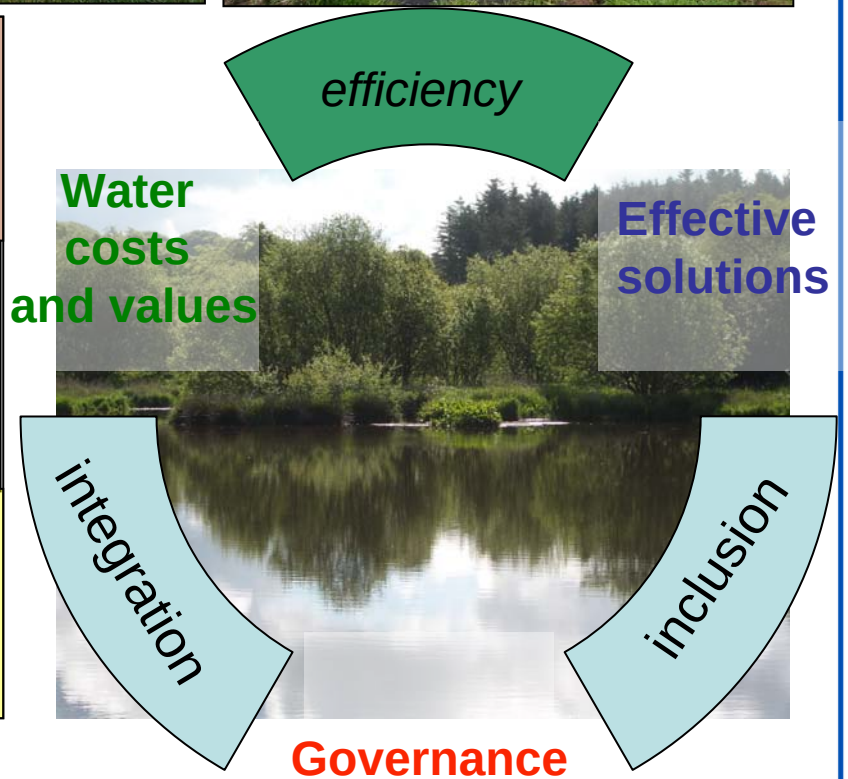
3. Does end user shows cost resistance ? -> assess disproportionality through Cost Benefit Analysis (CBA) etc.

Effective solutions - examples

1) Loch P mitigation

2) Waterborne pathogens and human health

3) Meeting NVZ standards



1. Loch P mitigation

P Standards for Good Ecological status (GES) from regulator

Prediction of P status of water bodies

- source apportionment of current P loads to 500 Lochs (and 3000 rivers)
- Likelihood of [P] exceedance for lochs (and rivers)
- P loading reductions needed for GES

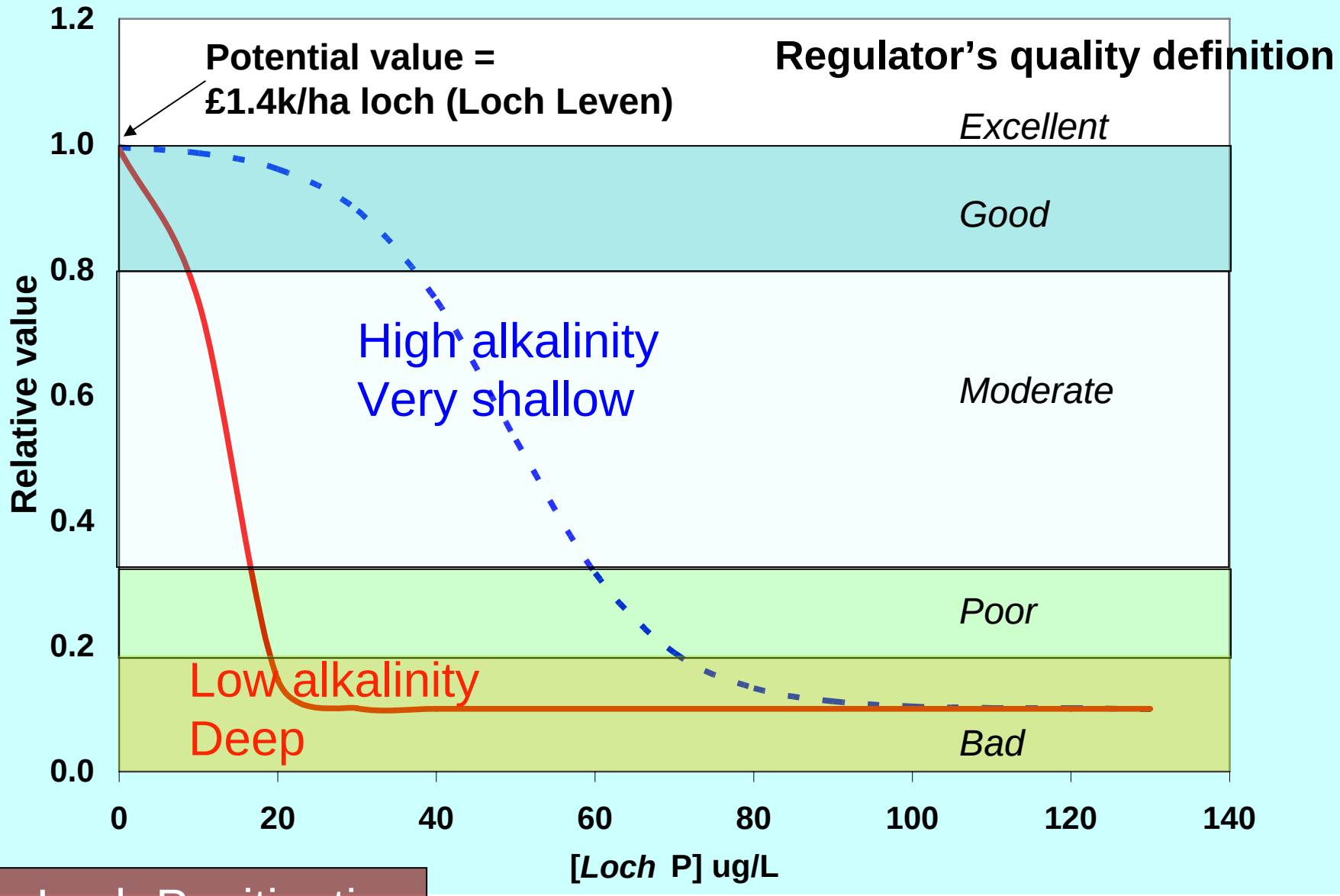
P Mitigation measures

- National scale land use and sewage inputs
- Mitigation cost curves for managed Grass, Arable, Upland, Septic tank and Sewage treatment works P

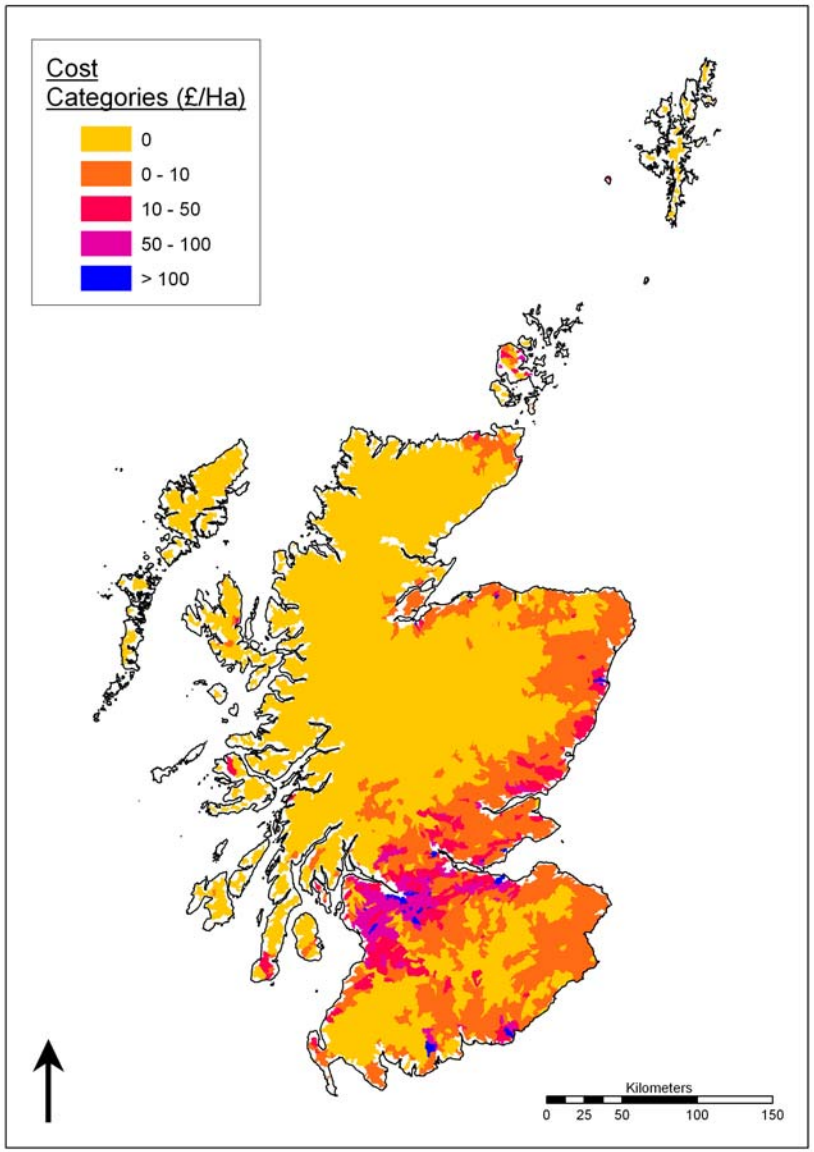
Mitigation cost minimisation across sources

Analysis of costs, disproportionality and uncertainty

Interim approach to loch values

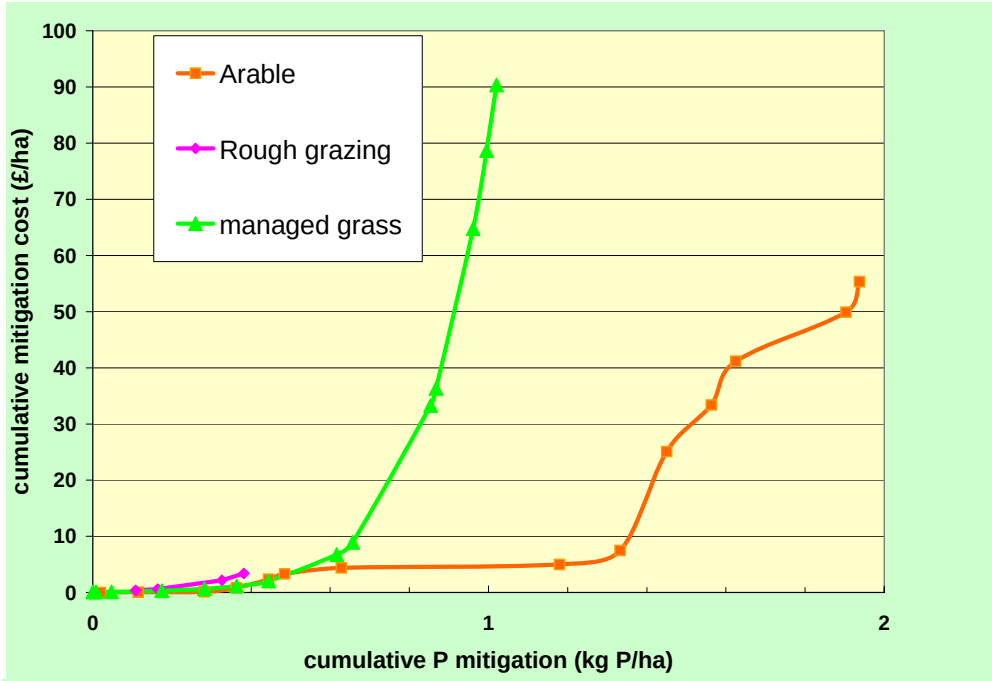


Load reductions and costs



Mitigation Cost to achieve 80% likelihood of good P status for rivers (40 ug/L)

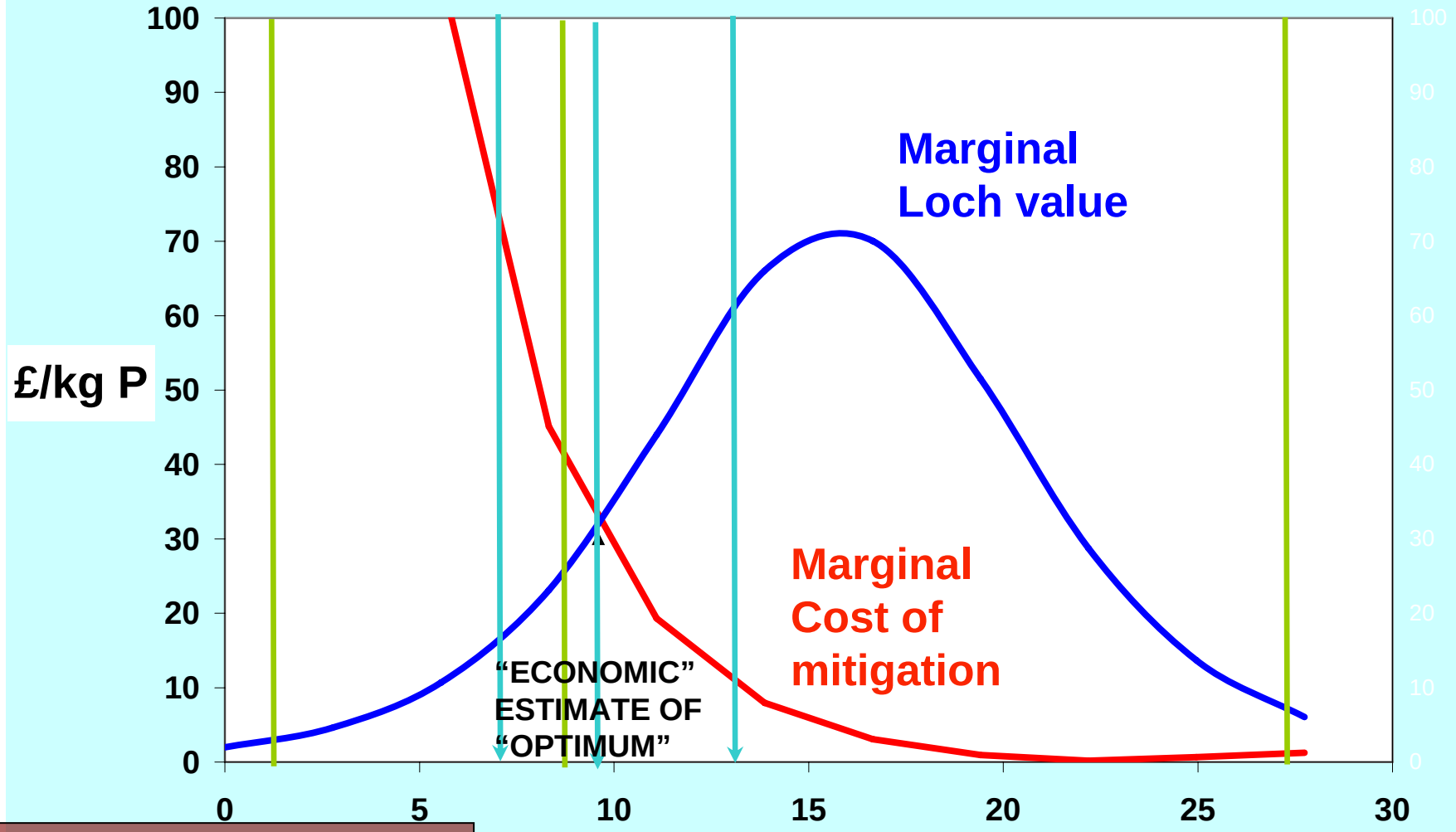
Mitigation cost curves – eg DEFRA, Scottish Best Management Practices Handbook



Environmental Economics of Lochs

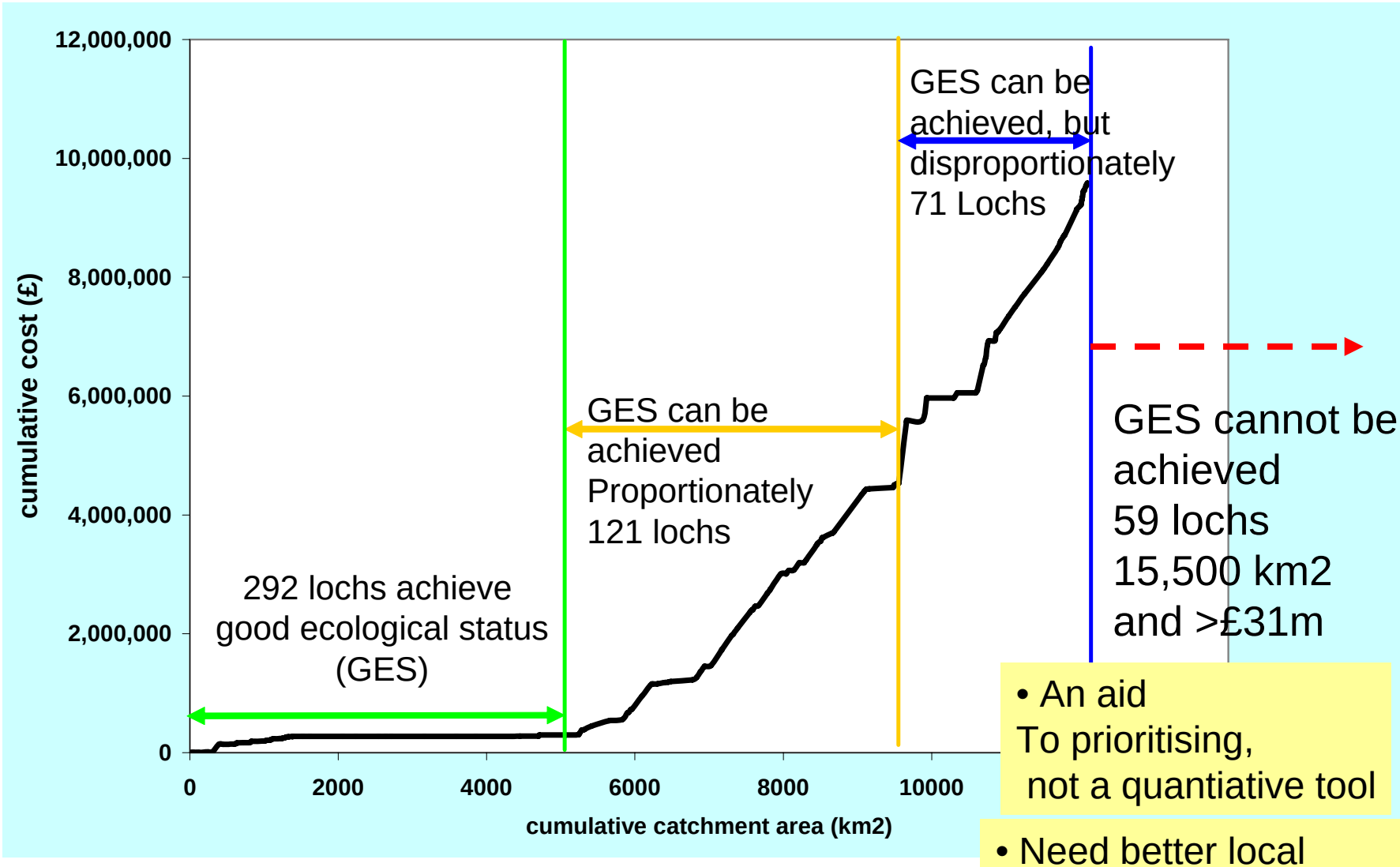
Regulator's Good Ecological Status

Current predicted status



1. Loch P mitigation

Disproportionality analysis for Loch P mitigation



- An aid To prioritising, not a quantiative tool

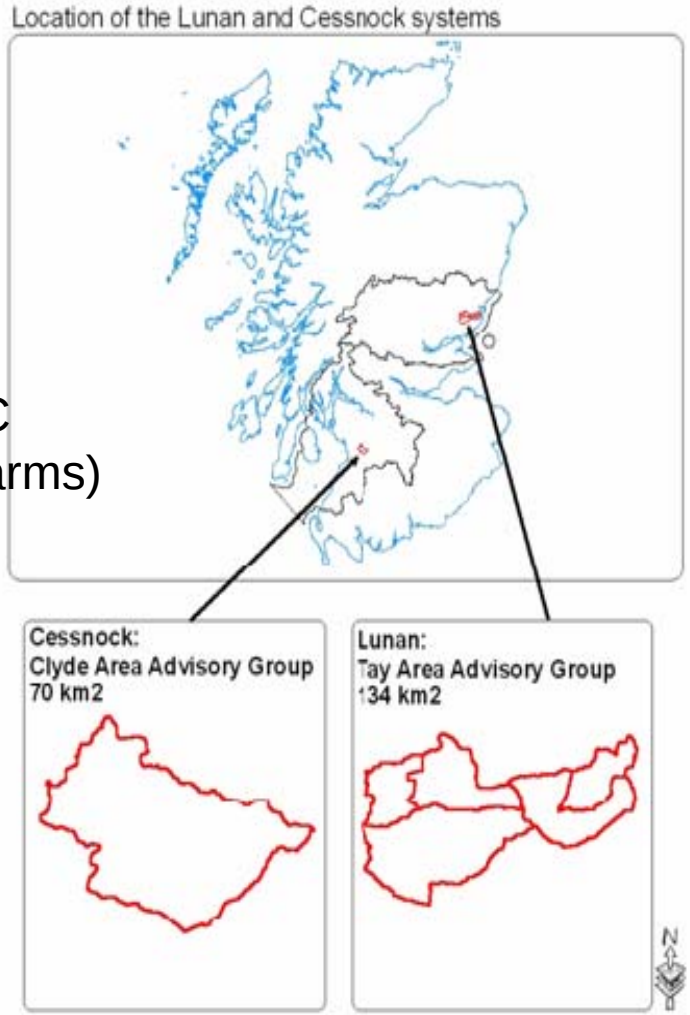
- Need better local characterisation of costs And effectiveness

Monitored priority catchments

SEPA (measures)

Macaulay (catchment research)

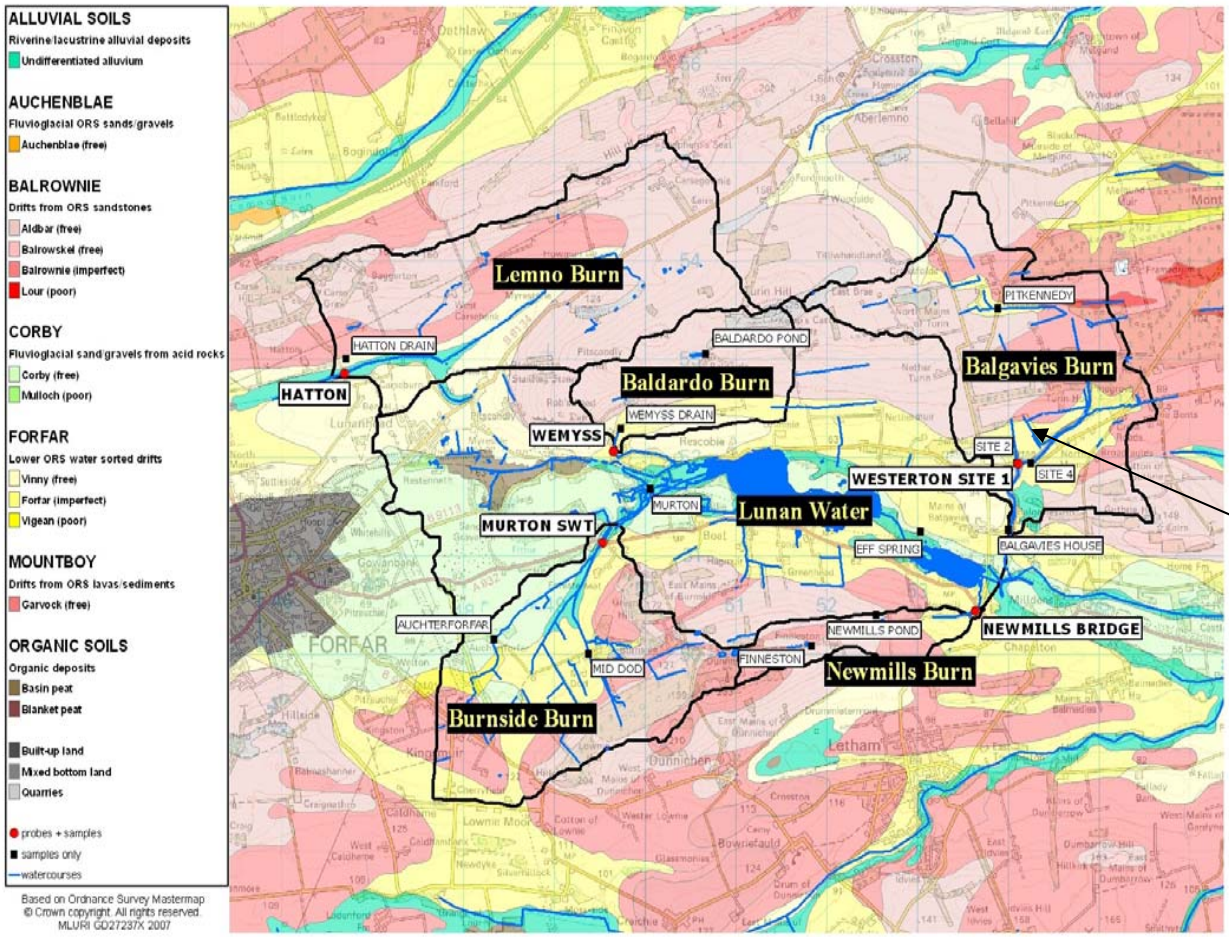
SAC (focus farms)



Typical dairy and mixed catchments

Lunan: Monitored Priority Catchment

5 subcatchments monitored for turbidity, chemistry



How effective are
- Statutory measures
- Voluntary measures

in achieving Good Ecological Status ?

General Binding Rules farm audit process has begun, through Environmental Focus Farm

1. Loch P mitigation

1. P mitigation: POLICY IMPLICATIONS :

There is potential for proportionate spend on P mitigation of Lochs

More difficult to justify for rivers because multiple stressors control ecology and ecosystem services

Need more local validation of cost:effectiveness

2. Pathogens: risk assessment

Benefits and costs

Bathing waters project costs data

Benefits transfer from E and W to Ayrshire

Sources

Apportionment using faecal sterols

Variation in space and time

Doses and responses

Role of mixing

Quantitative risk assessment

Transport and attenuation

Mitigation using ponds/wetlands

bacteria-colloid interactions

Quantifying *E.coli* sources on dairy farms

ISCO auto samplers

Pond and wetland

Steading + Lagoon

A 2005

B 2005

C 2005

D 2005

Access track to fields

HYDROLAB SONDES

Restricted access recommended

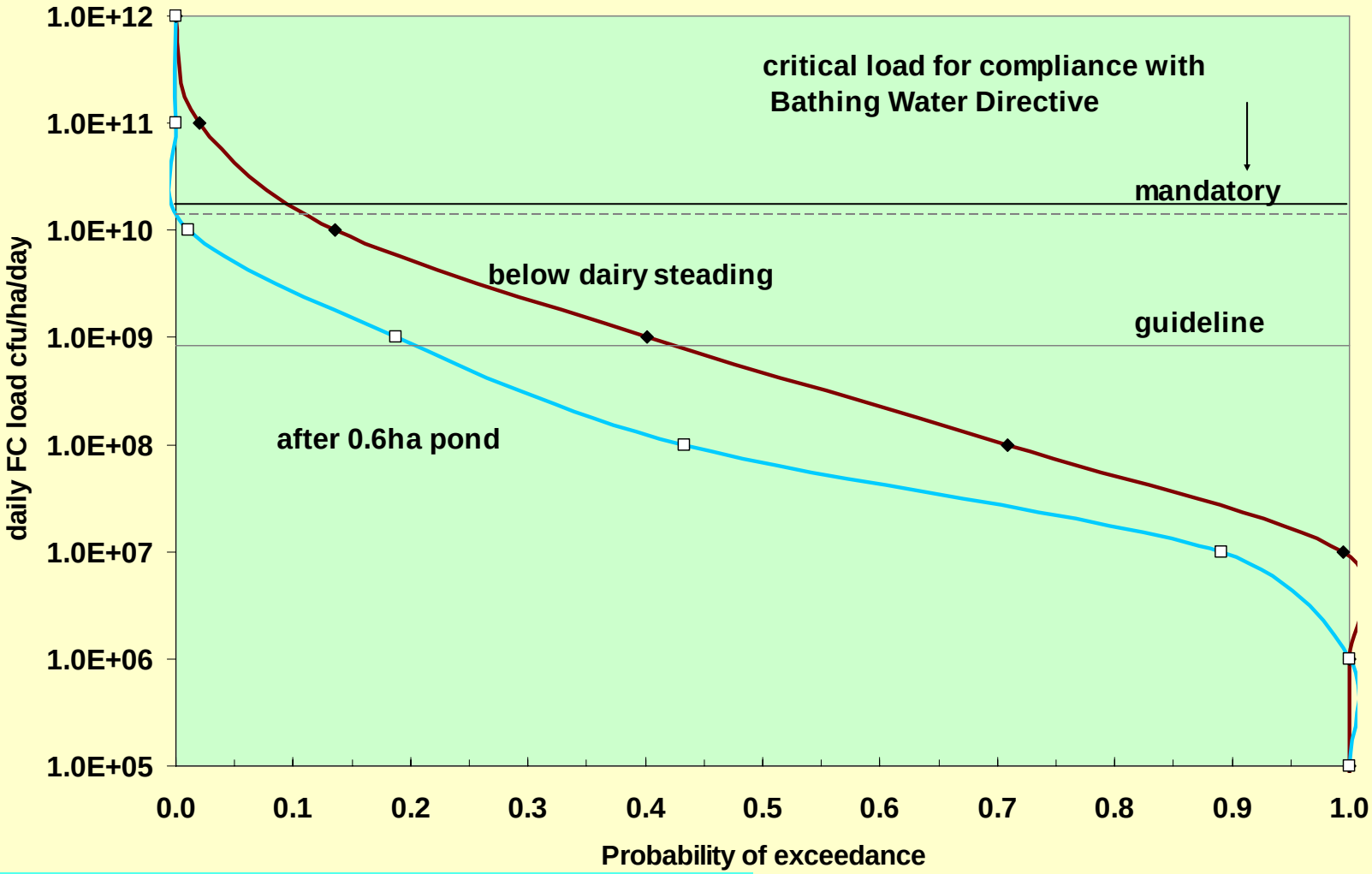
Restricted access helpful

100m

2. Pathogens: risk assessment

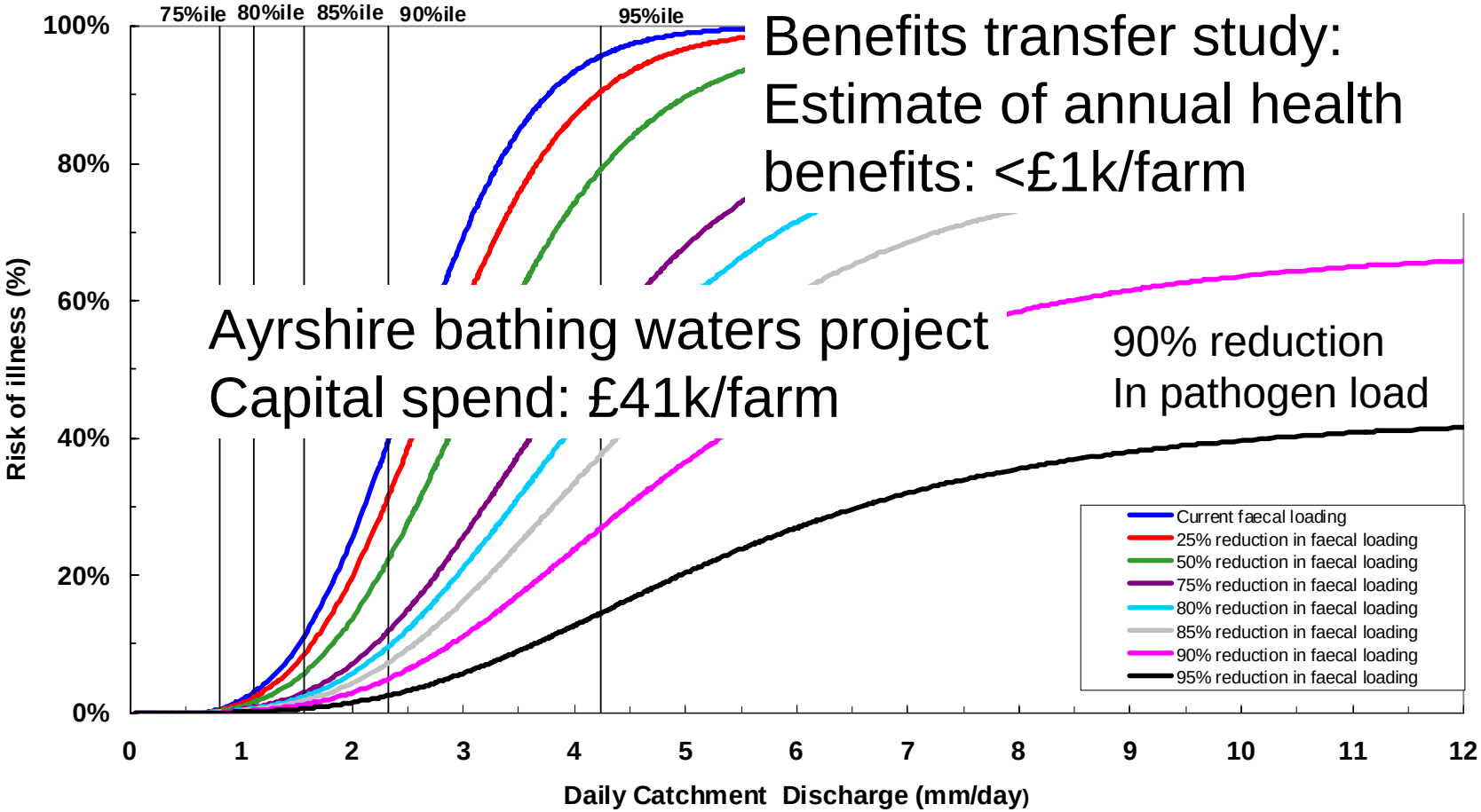
Farm ponds mitigation of faecal pathogens

Faecal coliform loading exceedance in stream



2. Pathogens: risk assessment

Risk of enteritis from bathing at Irvine Beach



Benefits transfer study:
Estimate of annual health benefits: <£1k/farm

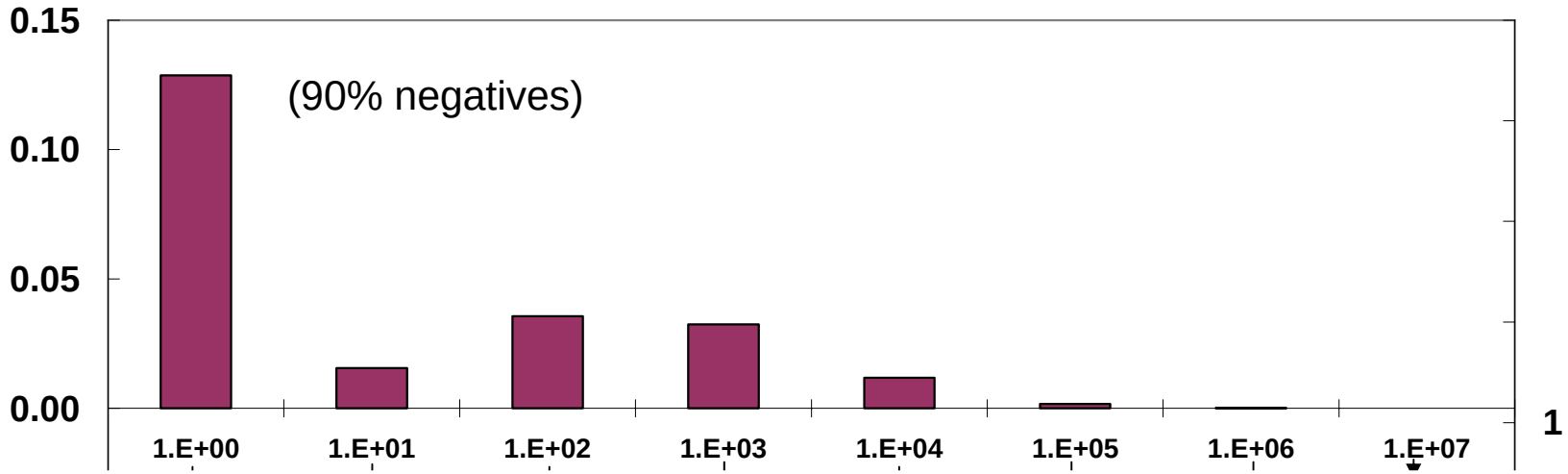
Ayrshire bathing waters project
Capital spend: £41k/farm

90% reduction
In pathogen load

Johnstone, Moran and Vinten, 2007

Role of mixing in risk of infective dose

Frequency distribution of *E.coli* O157 in leachate from individual faeces (cells/100mL)



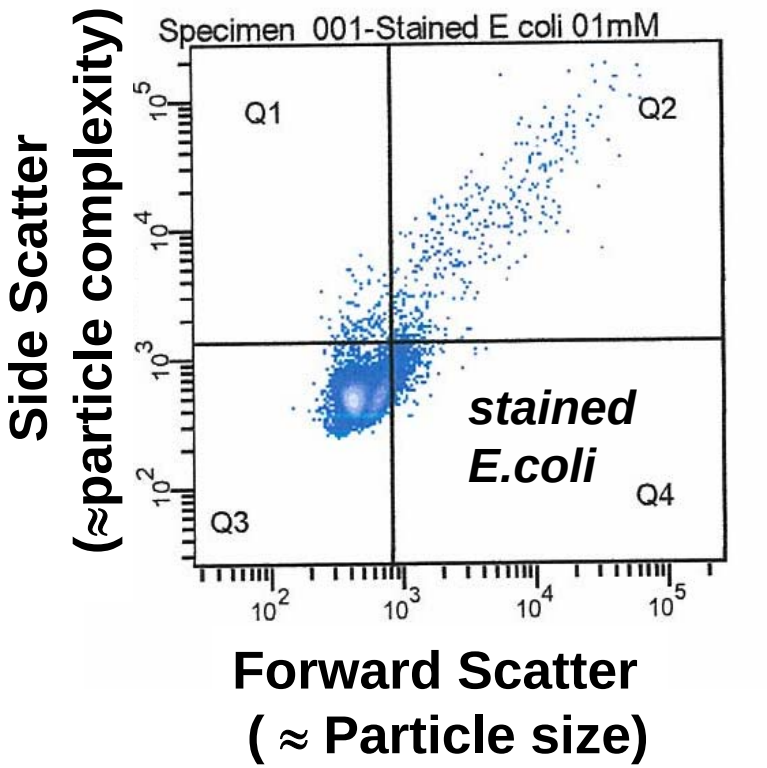
Log(dose)

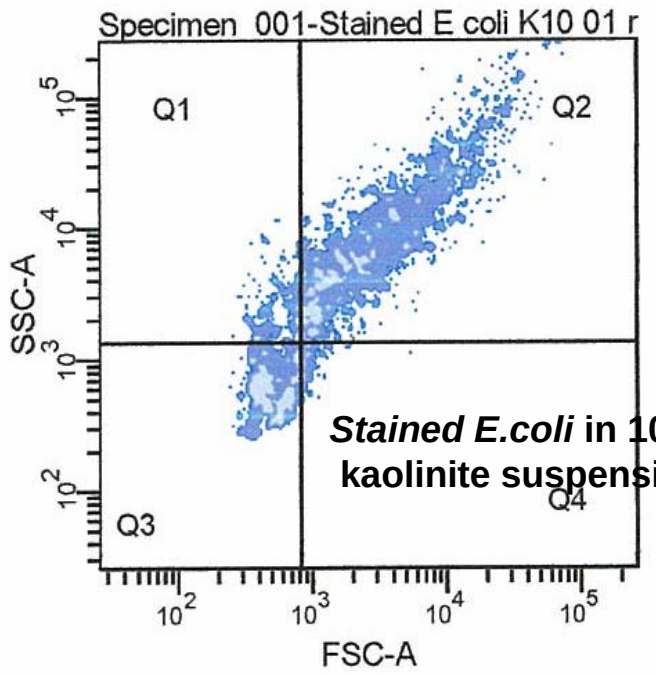
E.coli-colloid interactions

Flow cytometry measures
Particle size, complexity,
And fluorescence

→

E.Coli is strongly associated with colloids => Imperfect mixing





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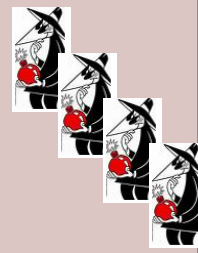
Avery et al. 2008

Predicted incidence of E.coli O157 infection

Assumption used for E.coli O157 mixing to estimate incidence (λ)	source	
	Aberdeenshire Private Water supplies	Ayrshire Bathing Waters
Using frequency distribution of *E.coli O157* in faecal pats ie NO MIXING	per 100,000(y^{-1}) 29	8 
using arithmetic mean ie COMPLETE MIXING	1766	467 
Incidence of lab. isolates in humans (Reilly, 2002)	Aberdeenshire: 13.4	Ayrshire and Arran: 7

What are the mixing rates and processes ?

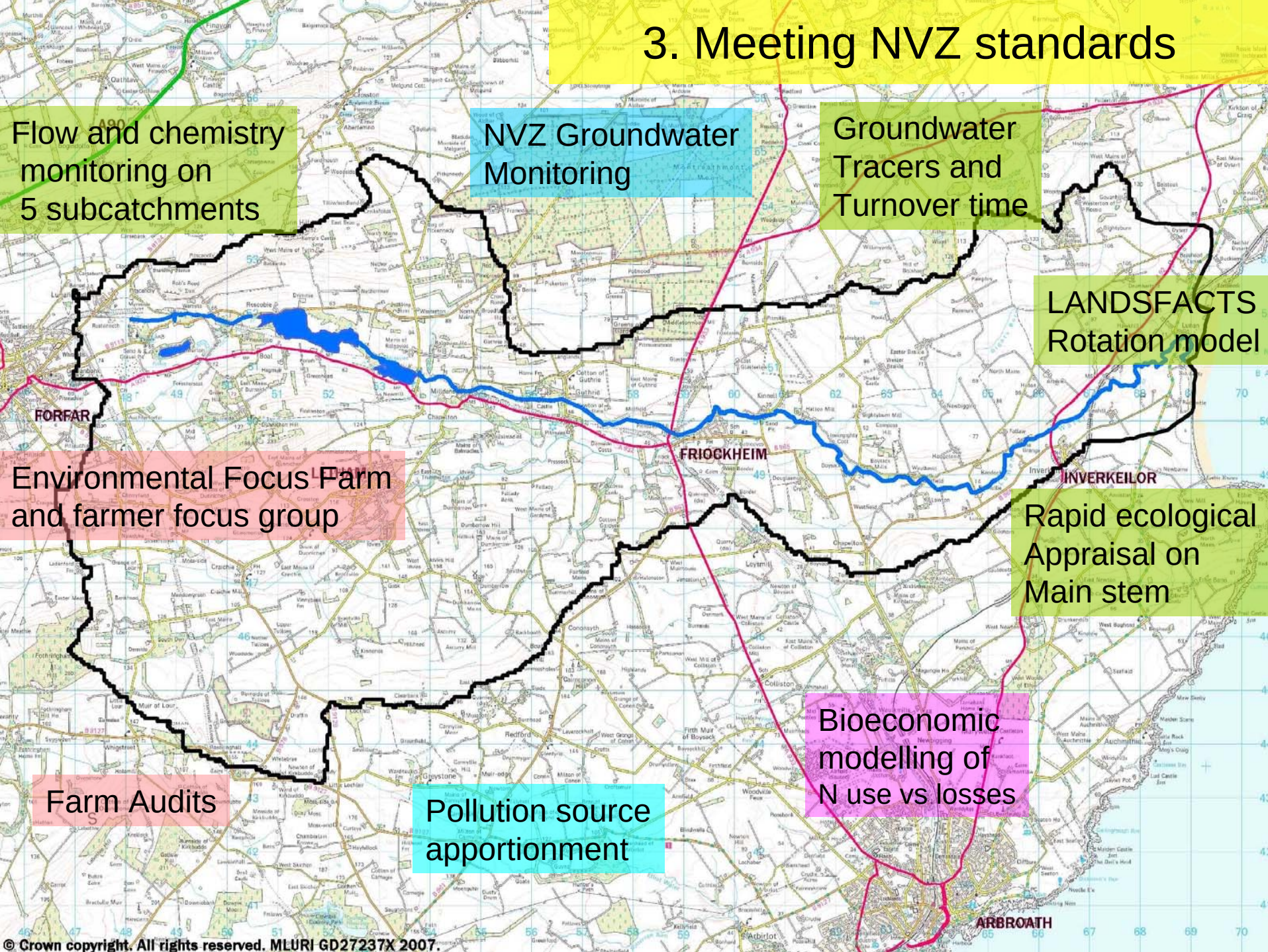
Vinten et al. 2008, in press

Pathogens: POLICY IMPLICATIONS :

Grazing livestock may be a lower risk than expected because of incomplete mixing

Mitigation not proportionate unless multiple benefits considered

3. Meeting NVZ standards



Knowledge Exchange activities

- Nutrient budgets:

potential win-win situations identified on farms across catchment

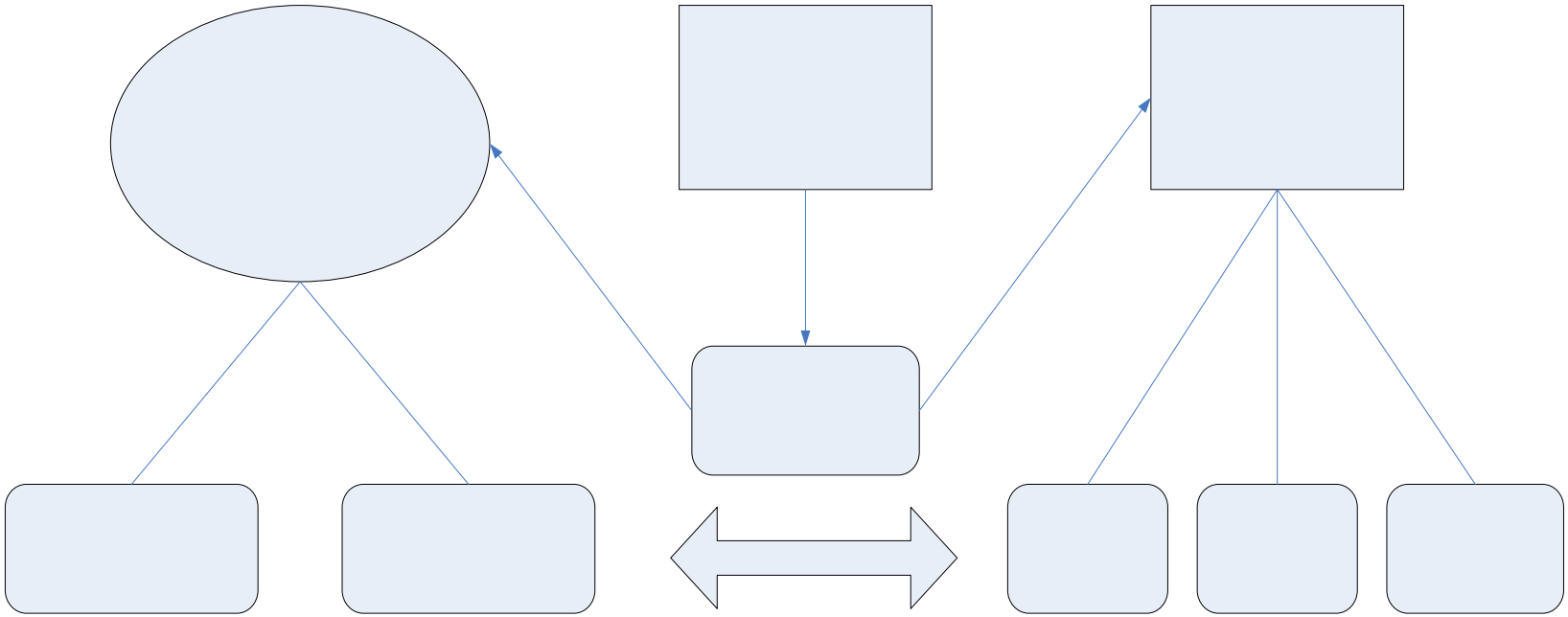
- Precision farming:

yield and pH maps tell us how to improve N use efficiency

- General Binding Rule Audits

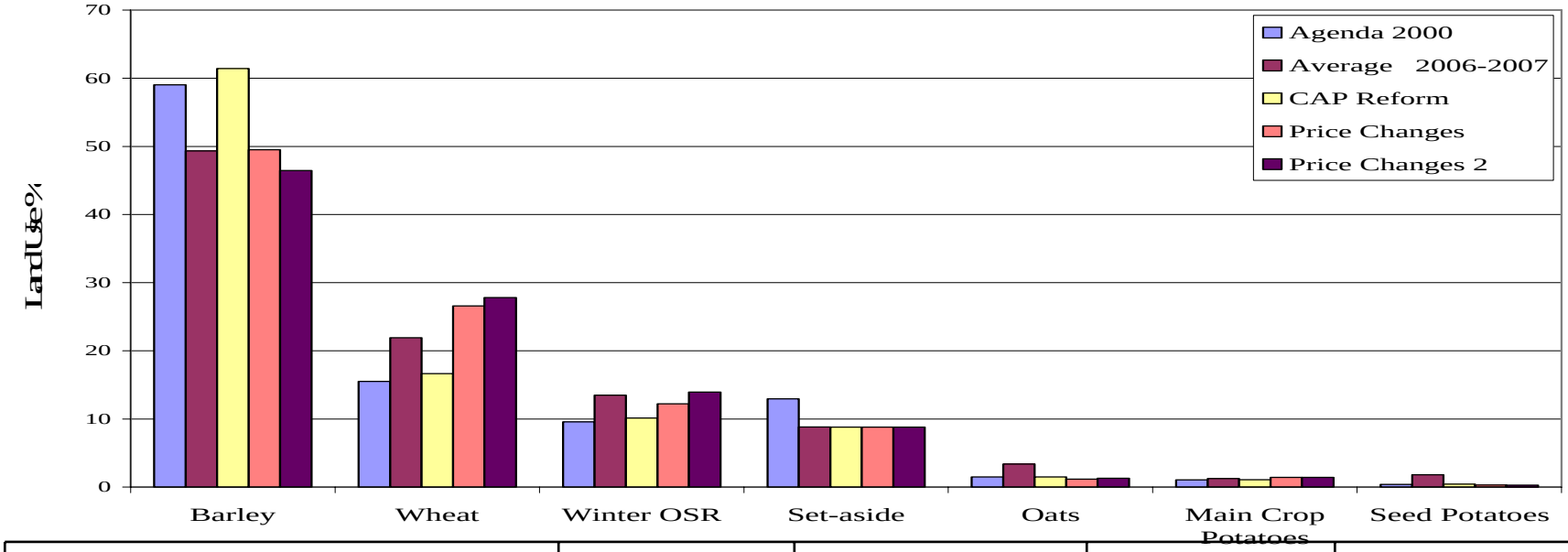
- Erosion risk mapping

Economic and Water Quality Effects of the 2003 CAP Reform on Arable Cropping Systems



3. Meeting NVZ standards

N losses from average Cereal farm

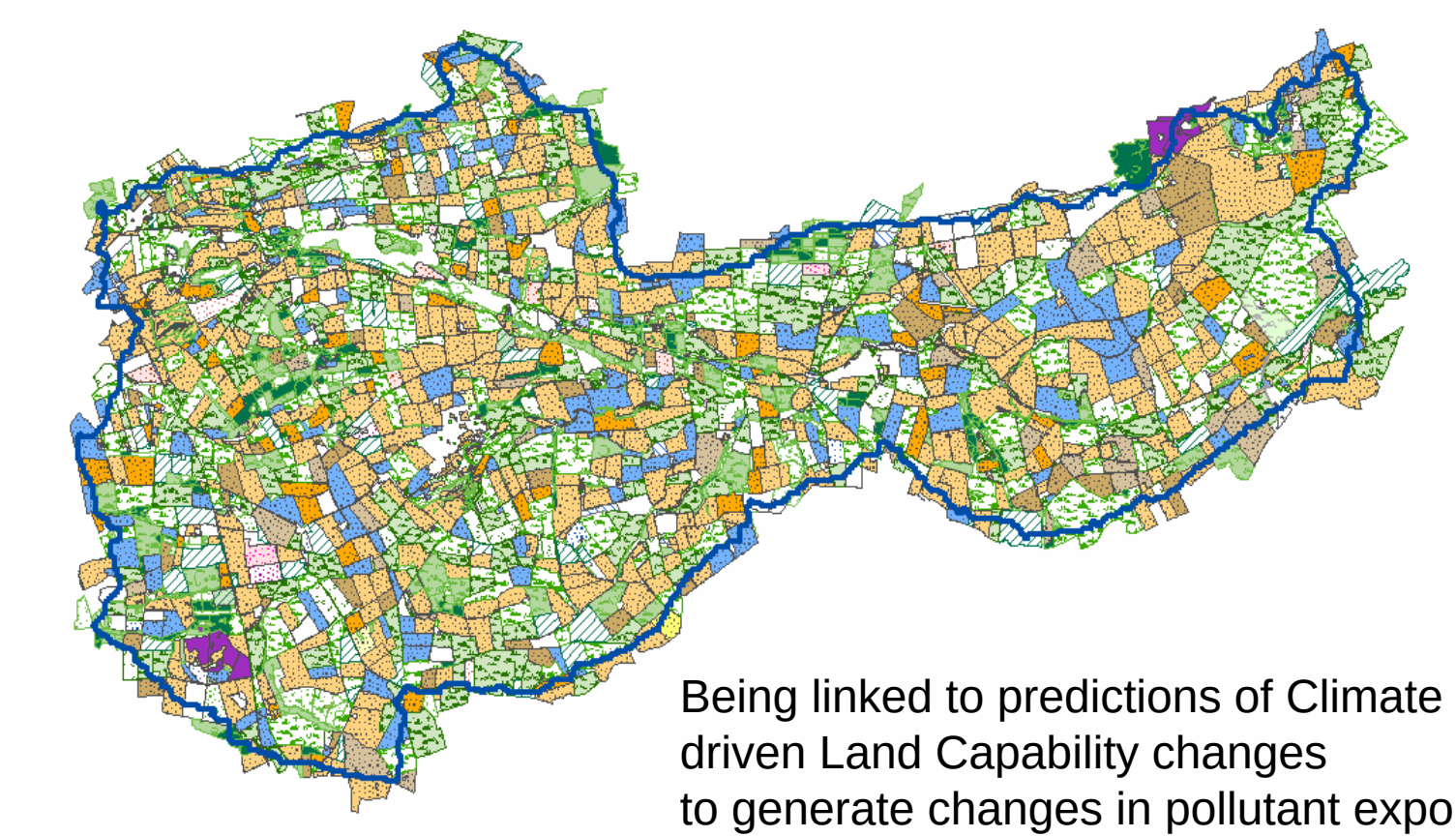


	Agenda 2000	CAP Reform	Price Changes	Price Changes 2
Utility (£)	15405	15010	17164	17364
Farm income (£)	21866	21821	24246	24858
Income per ha (£/ha)	463	462	514	527
Premiums (£)	9003	8482	8482	8482
Premium share of income (%)	41	39	35	34
Nitrogen use (kg/ha)	162	170	170	180
Nitrate leaching (kg/ha)	70	73	72	71

Mouriatidou, Moran, Topp, 2008

3. Meeting NVZ standards

LANDSFACTS model of crop rotation

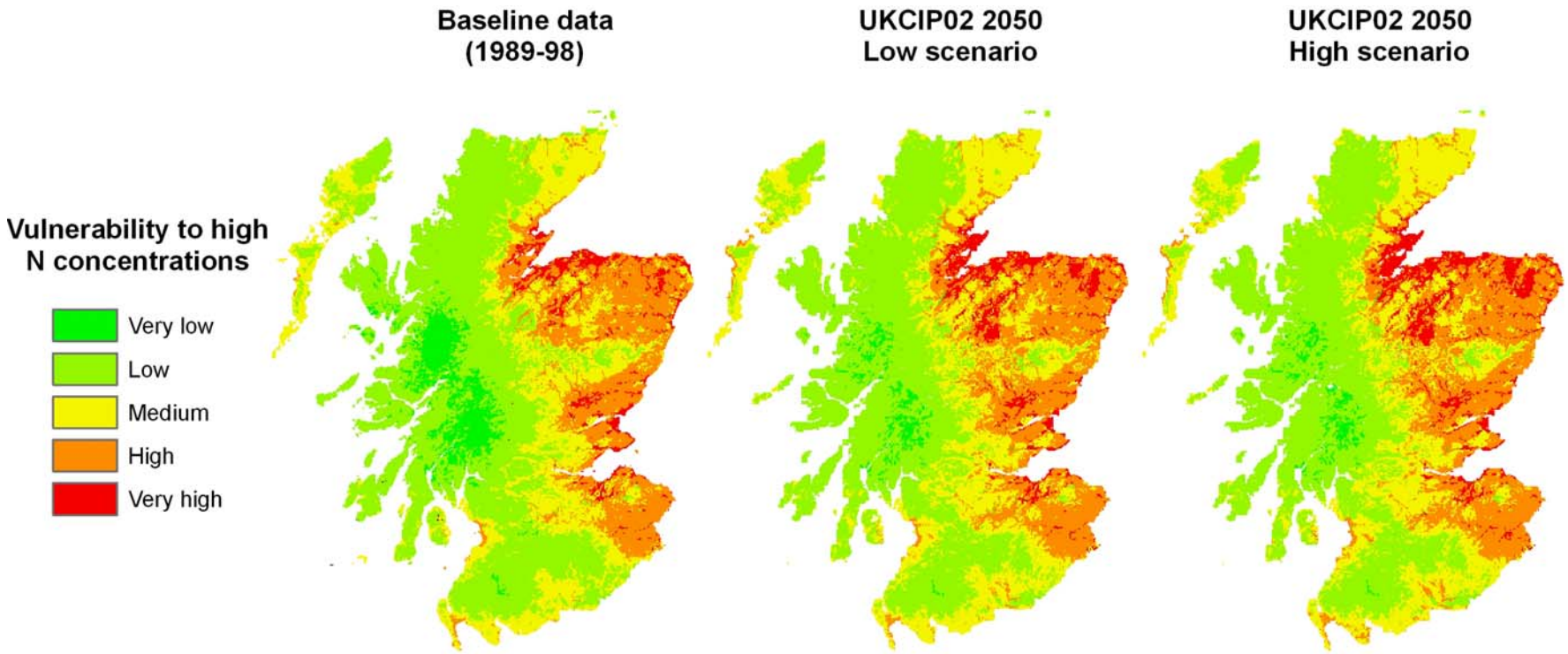


Being linked to predictions of Climate change driven Land Capability changes
to generate changes in pollutant export

3. Meeting NVZ standards

National Assessment – N Vulnerability

- Physiographic vulnerability to high N concentrations
  - Driven by soils, climate, and excluding land use



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3. Meeting NVZ standards

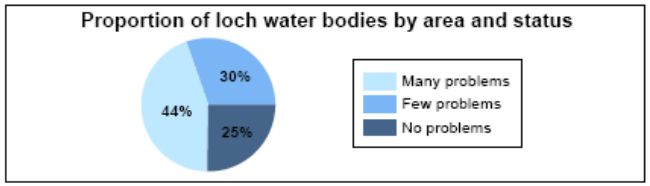
POLICY IMPLICATIONS

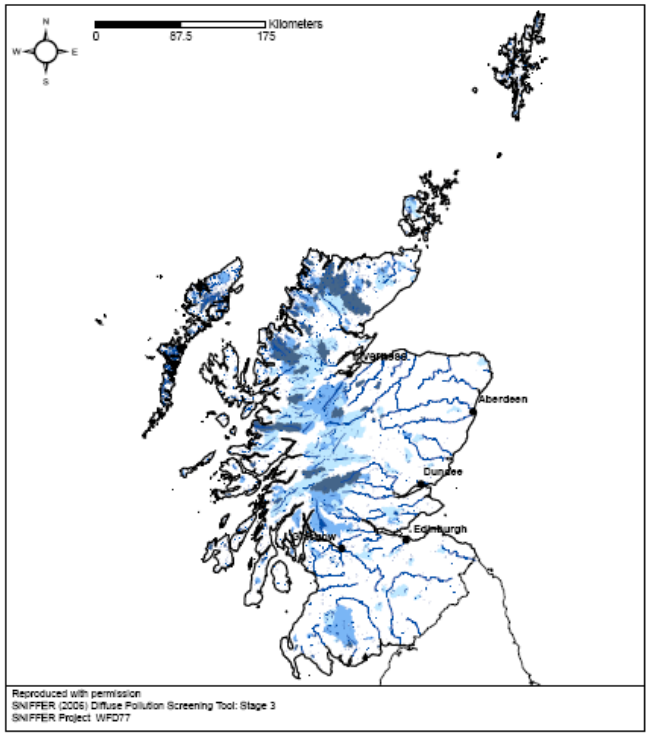
N mitigation may not be proportionate because:

- Time delays leading to severe discounting
- Difficulties with stakeholder buy-in when results are delayed
- Large scale land use change (as opposed to improved management) may be needed
- Does this fit with need for integration and inclusivity?

3. Meeting NVZ standards

Choice experiment





Based on DEFRA approach but:

- Lochs and Rivers covered separately
- Descriptions of water quality modified to Scottish conditions
- Includes morphological pressures

WILLINGNESS TO PAY for Good Ecological Status

	£ per year	Confidence Intervals (95%)
Per ha of river catchment area	**25**	**18 - 36**
Per ha of loch water surface area	**3,706**	**2,696 - 5,407**

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efficiency

Water costs and values

Effective solutions

integration

inclusion

Governance